US-PAT-NO: 5513248
DOCUMENT-IDENTIFIER: US 5513248 A
TITLE: Cordless telephone micro-cellular system

Drawing Description Text - DRTX (8):

FIG. 6 is a flow diagram of a process suitable for incorporating into the cordless telephone system of FIG. 1 operative in handing-off each handset unit from an active base unit to an idle base unit, in accordance with the invention, when the radio link quality of the active base unit deteriorates to below an acceptable level.

Detailed Description Text - DETX (8):

For initial configuring of the cordless telephone system, by way of a brief example, after the master base unit is plugged into a standard 115 volt source, this unit transmits the start pulse in slot 201 for providing a synchronizing signal for the satellite base units in the system and then its identifying data to these satellite base units in communication slot 202. This identifying data includes its ID code, the frequency channel upon which it operates, an identifying code for any other stations it identifies as being in the system and the communication slots occupied by these stations. It also includes in this communication slot 202 calling data which seeks a response from any unknown satellite stations also present on the tip/ring line 101. When satellite base unit 13 first responds, for example, a communication slot such as slot 203 is established by master base unit 12 for use by satellite base unit 13 for all subsequent communications from this satellite base unit 13 to the master base unit 12. In order to avoid collision between the satellite base units 13 and 14, (and any other satellite base units in the system) which could result if they both attempted to respond at the same time, each satellite base generates a "pseudo-random" number from between 0 and 10. This number is then used in determining a delay time for responding such that message collisions between the satellite base units are avoided. The need for a random transmission time arises from message collision considerations when two base units transmit at the same time, both calculating idle time from the same event.

Detailed Description Text - DETX (17):

In operation by way of a brief example, if handset unit 16 is communicating with satellite base unit 13 and the user of this handset unit wanders out of the operating range of this base unit into the operating range of satellite base unit 14 which is then on-hook (not communicating with another handset unit), handset unit 16

will be handed off from base unit 13 to the satellite base unit 14. In this hand-off, the radio link between base unit 13 and handset unit 16 will be terminated and a new radio link between the base unit 14 and handset unit 16 will be established. Like handset unit 16, the other handset units 15 and 17 may be handed off to any other idle base unit in the system. The only requirement is that this other base unit not be actively communicating with another handset unit.

Detailed Description Text - DETX (18):

Multiple handset units may be off-hook at the same time. Each handset unit must be within the reception range of an idle base unit, however. Since each base unit has in its internal table the assigned channel for each other base unit and since these base units are configured to scan the channels assigned these other base units, any base unit can respond to a request-for-service signal from any handset unit configured for operation in the system. If, for example, a first handset unit has established a communications link with a first base unit in the system and a second handset unit goes off-hook and generates a request-for-service signal, if this second handset unit is within the reception range of a second base unit not then engaged by another handset unit on a communications link, then this second handset unit will establish an communication link with this idle base unit. Thus a person involved in a conversation with a distant party using the first handset unit in the system may have a second party join in the conversation on a second handset unit in the system without channel conflict or interference.

Detailed Description Text - DETX (28):

When communicating with a handset unit, the transmit and receive signals of the base unit 12 are coupled to a duplexer 125 which permits the transmitter 122 and the receiver 123 to both simultaneously operate over antenna 124 while preventing the output of transmitter 122 from being coupled directly to the input of the receiver 123. Although a duplexer circuit has been included in the base unit (and also the handset unit), it should be understood that such duplexer is purely illustrative and that in a time division duplexing arrangement, in which this invention is also applicable, a duplexer is not necessary. When the base unit is in an idle state awaiting an incoming telephone call or a request-for-service signal from a handset unit, transmitter 122 is turned off while receiver 123 remains on to detect the request-for-service signal. A signal strength monitor circuit 126 is connected to receiver 123 for monitoring the strength of a signal received from a handset unit while that handset unit is communicating with one of the base units in the system. The operation of this circuit is described in greater detail later herein. The telephone circuit 400 serves as an interface for control signals provided over the tip/ring line 101 between the control unit 120 of base unit 12 and the control units respectively

associated with base units 13 and 14. The telephone circuit 400 also serves as the interface for voice signals over the tip/ring line 101 which are sent to transmitter 122 and received from receiver 123.

Detailed Description Text - DETX (31):

In order to conserve battery power, a controlled power up/power down mode of operation for the handset unit 15 is implemented in accordance with the teachings of U.S. Pat. No. 4,731,814 issued to W. R. Becker et al. on Mar. 15, 1988. The battery 157 in the handset unit is normally charged while the handset unit is placed in a cradle located in, for example, its associated base unit. When the handset unit is removed from this base unit and is in an idle or standby state awaiting a telephone call, power to the control unit 150, receiver 152 and certain other selected circuitry in the handset unit 15 is controlled to minimize power consumption. Power to other non-essential circuit, in the handset unit 15 is turned completely off during this state. The handset unit automatically turns on to a full operating mode from the controlled power up/power down mode in response to events such as a user depressing a key on the keypad 158 or the receipt of a broadcast ring indication from a base unit, this ring indication being indicative of an incoming call detected on the tip/ring line 101.

Detailed Description Text - DETX (45):

Channel cycling is employed by both the master and satellite base units to assure that all handset unit service requests are received when a handset unit is beyond the operating range of its assigned base unit. In the operation of channel cycling, each satellite base unit is informed by the master base unit of the frequency channels being used by each handset unit. The master base unit and the satellite base units then listen for service requests on each one of the channels assigned to a handset unit operating within the cordless telephone system. Each one of the base units cycle through each of the channels, dwelling for a short period, typically 0.5 seconds, on each channel in order to receive any service requests from a handset unit then using that channel. The channel cycling operation is executed by each idle base unit until either a task of greater priority is presented by the control unit 120 in master base unit 12 or it receives a service request from a handset unit.

Detailed Description Text - DETX (46):

In order for an idle handset unit to request service from a base unit (e.g., to originate a call or change channels), the handset unit must be within the operating range of a base unit and the base unit must be on the same channel as the handset unit or move to the channel in time to respond to this request. The control unit 120 in base unit 12 not only informs the satellite base units of the

channels currently being used by all the handset units, but also when a handset unit is changed from one operating channel to another. If a user executes a channel change operation on the handset unit he or she is then using, this information is passed via the active base unit back to the control unit 120 in base unit 12, which informs the control units in the other base units of the change. Thus, if the handset unit is communicating with its assigned base unit when the user changes channels, the other base units are informed of the change and which new channel to periodically cycle to and monitor in order to receive a service request from that handset unit. Similarly, if the handset unit is communicating with other than its assigned base unit when the user changes channels, the other base units are informed of the handset unit's changing channels and which new channel to also periodically cycle to and monitor (one channel for each handset unit operating in the system). The assigned base unit also is informed of the new channel which it must monitor while in the idle condition for subsequent communications with this handset unit, such as providing to it the initial broadcast ring indication. The active base unit through which the handset unit was then communicating, when it returns to the idle condition, also returns to monitoring the channel commonly assigned to it and its associated handset unit.

Detailed Description Text - DETX (50):

With reference to FIG. 6, there is shown a flow chart illustrating the operation of the cordless telephone system in selecting an idle base unit and handing-off telephone communications with a handset unit to the idle base unit from an active base unit when the radio link quality of the active base unit deteriorates to below an acceptable level. The process is entered at step 601 where a handset unit is in an off-hook condition operating over an established radio link with an active base unit.

Detailed Description Text - DETX (51):

In order to achieve continuous coverage throughout the desired area in a premises, the signal strength monitoring circuitry in the active base unit and in each idle base unit, monitors the strength or radio link quality of the received signal from the handset unit while this handset unit communicates with the active base unit. Although the signal strength monitoring circuitry is provided in the base unit, it is understood that such monitoring also may be performed with similar circuitry includable in each handset unit.

Detailed Description Text - DETX (52):

Each idle shared base unit in the cordless telephone system reports to control unit 120 in the master base unit 12, shown in FIG. 3, its own radio link quality of the radio link existing during

communications between a handset unit and another base unit. The control unit 120 then stores and continually updates this information in temporary memory. In this manner, the control unit in the master base unit accumulates data reflective of radio link quality from all of the idle base units. As a user of a handset unit approaches the edge of the coverage area of an active base unit, the control unit 120 already has available the information it needs to execute a hand-off to the appropriate base unit.

Detailed Description Text - DETX (53):

When the received signal strength in the active base unit deteriorates to below an acceptable level as determined by decision 602, the control unit in this base unit determines that its radio link quality is POOR and then communicates this information to the control unit 120 in master base unit 12. If the radio link quality is acceptable in any idle base unit as determined by decision 603, the control unit 120, in turn, selects in step 605 the appropriate idle or new base unit for handing off the handset unit thereto and establishing communications therewith. The hand-off of step 606 is accomplished as follows: the control units in the old and the new base units mute the voice paths in these units, the new base unit is then instructed by its control unit to turn on its transmitter, and the control unit of the old base unit is instructed to turn off its transmitter, and then both base units unmute their voice paths. From step 606 the process is exited.

Detailed Description Text - DETX (54):

In the execution of the hand-off process, more specifically, each of the base units detect radio link quality through use of the signal strength monitor circuit 126 shown in FIG. 3 which may be, for example, a received signal strength indicator (RSSI) circuit. The RSSI circuit produces an output voltage that is proportional to the strength of the received signal from the handset unit. The base unit then compares this voltage relative to both a predetermined upper and a lower threshold level. An output above the higher threshold level indicates a GOOD link, an output between the two threshold levels indicates a TOLERABLE link, and an output below the lower threshold level indicates a POOR link. If a POOR link exists between the active handset unit and the base unit, the control unit 120 first attempts to hand-off the handset unit to a base unit with a GOOD link. If no idle base unit is found with a GOOD link, the control unit 120 immediately executes a hand-off of the handset unit to the first base unit found with a TOLERABLE link. If no base unit was found with a TOLERABLE link, the control unit 120 does not permit the base unit with the established communications link to hand-off the handset unit. Rather, the control unit in the active base unit is configured for optionally causing the handset unit to generate an audible and/or distinctive tone which is recognizable to the user that he or she is

then approaching the outer limit of the operating range for that handset unit in the cordless telephone system, as shown in step 604.

Detailed Description Text - DETX (62):

When a handset unit is off-hook with a base unit, this status is communicated over the tip/ring line to the other base units in the system by the base unit then engaged with the handset unit. Thus each base unit in the system, not already communicating with another handset unit, will periodically cycle to and monitor the channel then being used by each base unit/handset unit combination and determine the radio link quality of each of these communications links. This radio link quality is provided by each idle base unit in its communications time slot to the base unit then engaged with the handset unit so that should a hand-off of the handset unit becomes necessary, the base unit then communicating with the handset unit has available the status of the other base units, including their radio link quality. If the radio link quality between an in-use handset unit and the base unit then engaged with this handset unit degrades to an unacceptable level, this base unit then identifies an idle base unit in the system which has an acceptable radio link quality and signals this idle base unit with the stronger signal to go off-hook on the channel containing the existing radio link for communicating with the handset unit. The idle base unit switches to this channel and then goes off-hook for communicating with the handset unit while the base unit then engaged with the handset unit goes on-hook.

Detailed Description Text - DETX (64):

Other modifications of this invention are contemplated and may obviously be resorted to by those skilled in the art. An alternative implementation of the invention that is contemplated, for example, is the use of a separate free-standing control unit connected to each of the plurality of base units through the tip/ring line for switching the telephone service for each handset unit between the plurality of base units. Like the control unit 120 in the base unit 12 shown in FIG. 3, this free-standing control unit interfaces with the control units in each of the base units operating in the system, thereby controlling the selection of both an ID-code and a frequency channel by each of these base units. The free-standing control unit also is arranged to receive and store the radio link quality provided to it by each base unit monitoring a signal from a handset unit operating in the system. And when a handset unit should be handed-off to an idle base unit, the free-standing control unit makes this determination as well as selects the idle base unit which will receive the radio link for the handset unit. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.